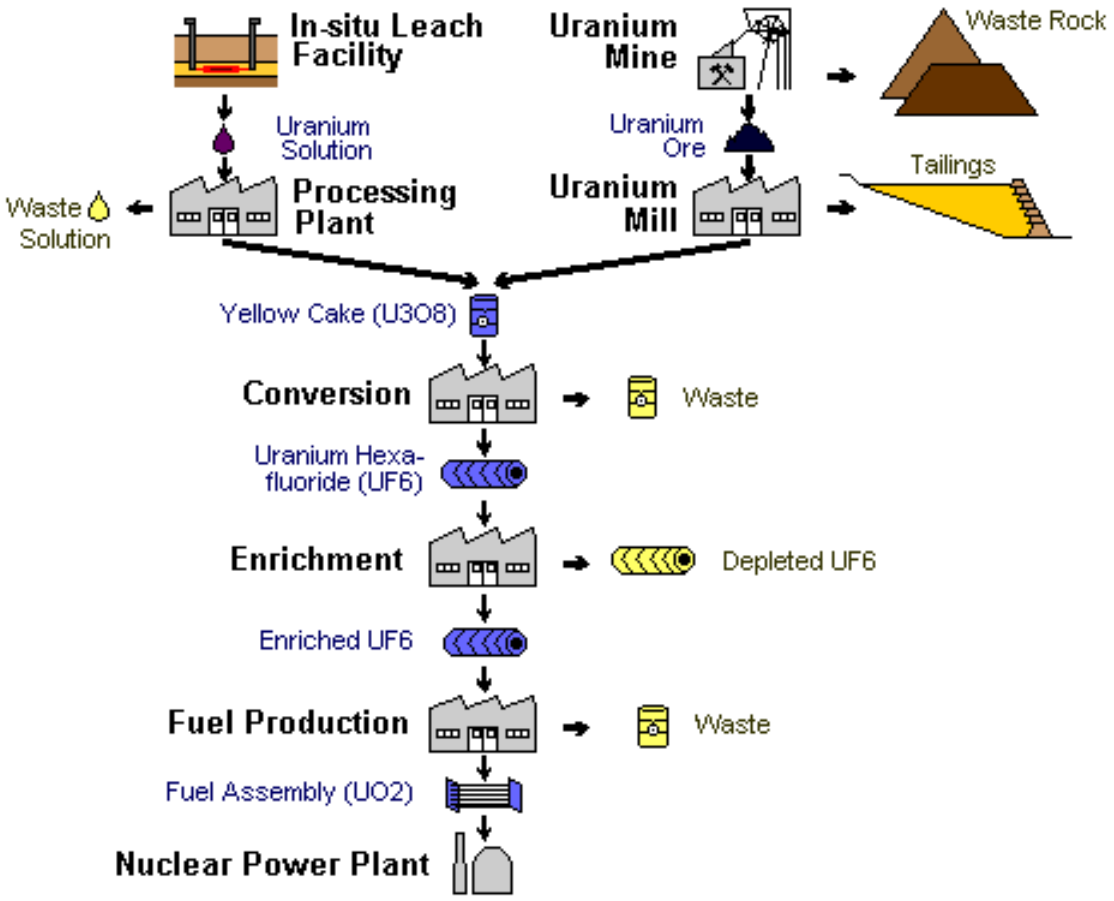
Nuclear Fuel Production Chain

(last updated 21 Mar 2006)

Nuclear Fuel Production Chain for Light Water Reactors

(clickable map)



===> **Explore the nuclear fuel production chain with WISE Uranium Project's Nuclear Fuel Chain Calculators:** <===

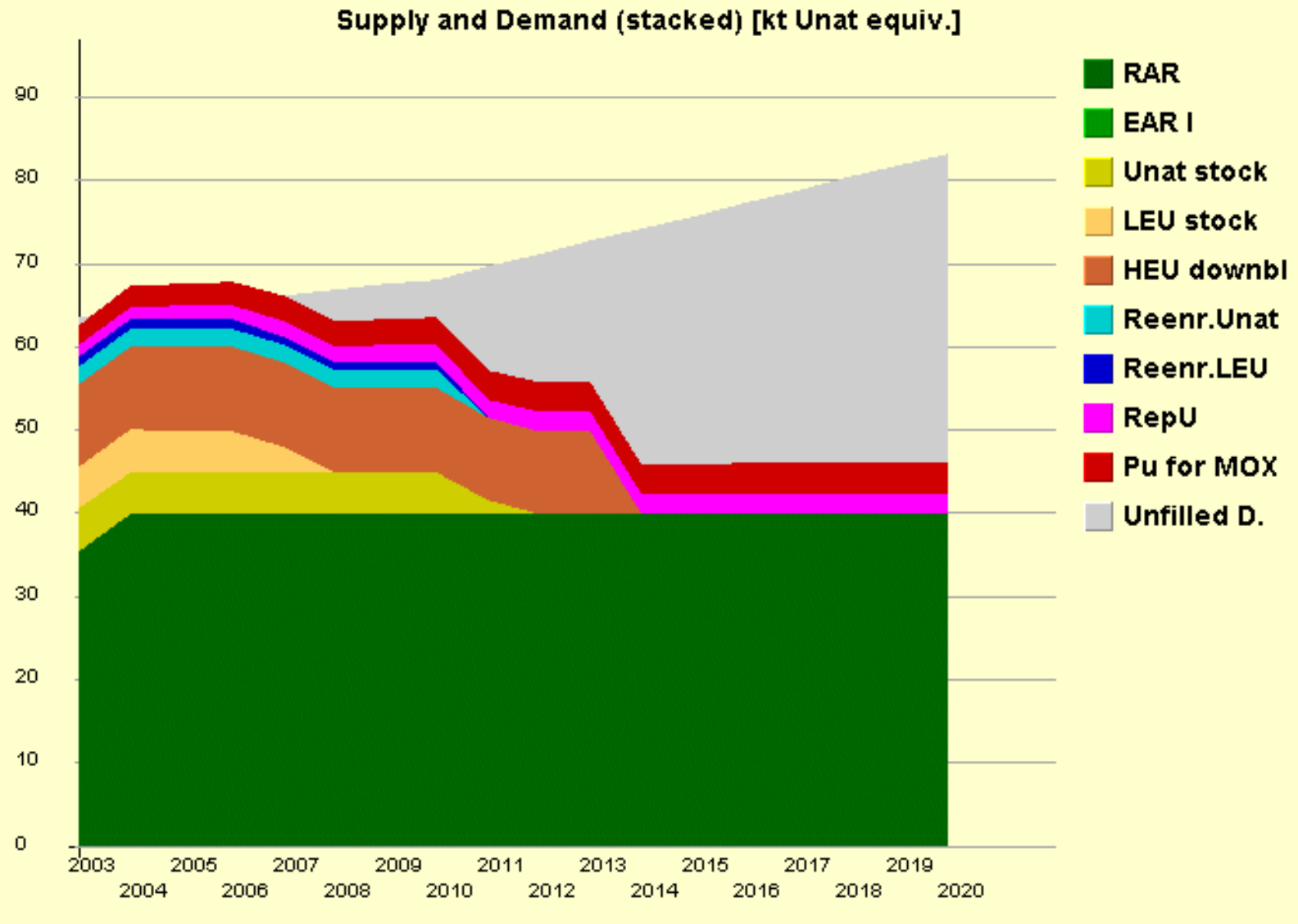
In the following, some results computed by the WISE Uranium Project Nuclear Fuel Chain Calculators are presented, covering Material Balance, Cost, and Health Risk for Residents from the production of nuclear fuel.

The following charts are screenshots of the graphical output of the respective calculators. These charts are based on the production of the amount of nuclear fuel that is required to fuel **one** 1300 MW reactor for approx. **one** year, allowing for an electricity production of 1 GWa_e, that is 8.76 TWh_e.
See the respective calculators (and their Help files) for the assumptions and parameter settings made. Use the calculators with your own parameter settings to obtain charts for different assumptions and situations.

Material Balance

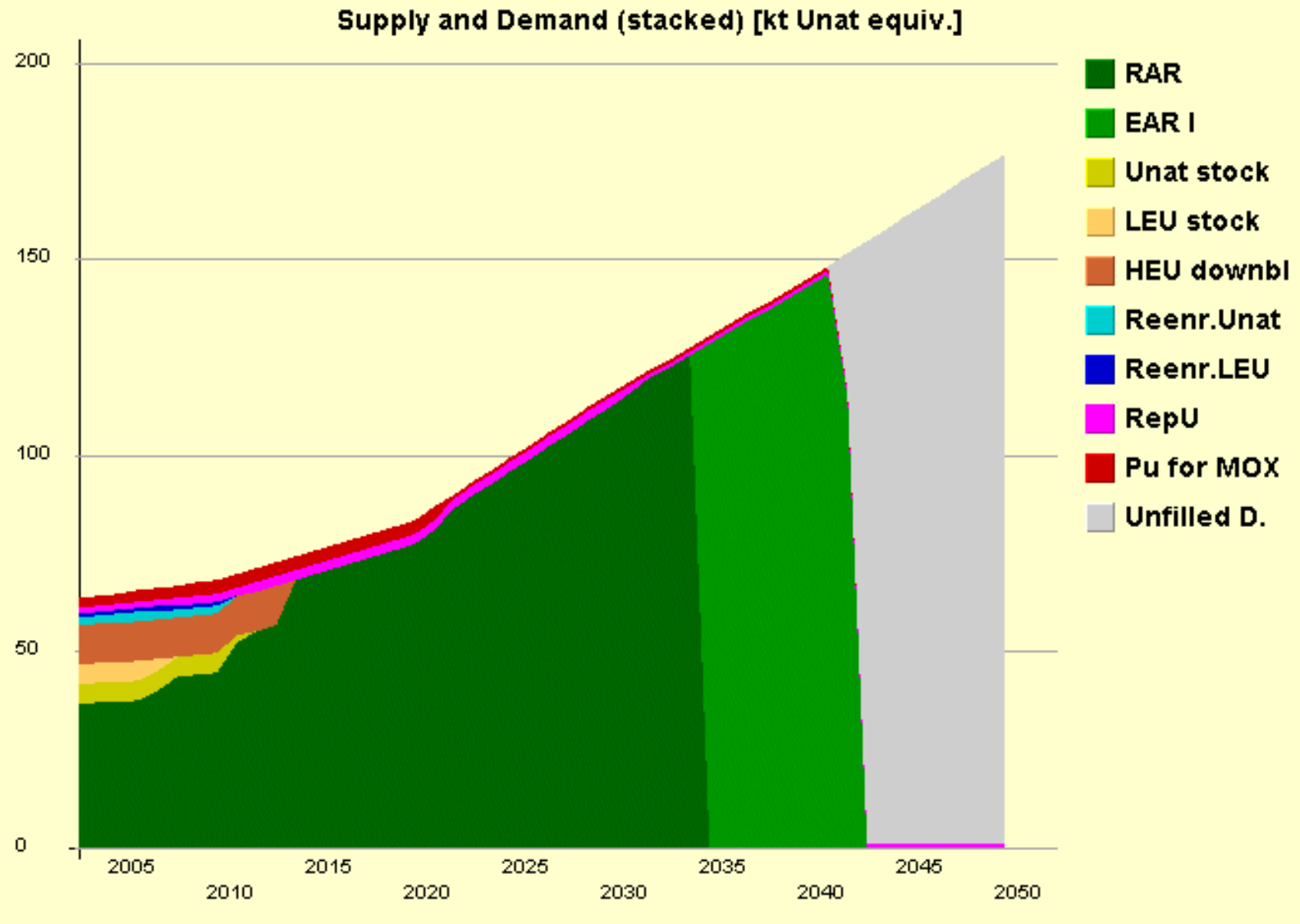
Nuclear Fuel Supply and Demand

Within a few years, uranium may become a scarce resource, since production from mines currently supplies only about half of the demand, and secondary supplies are expiring.



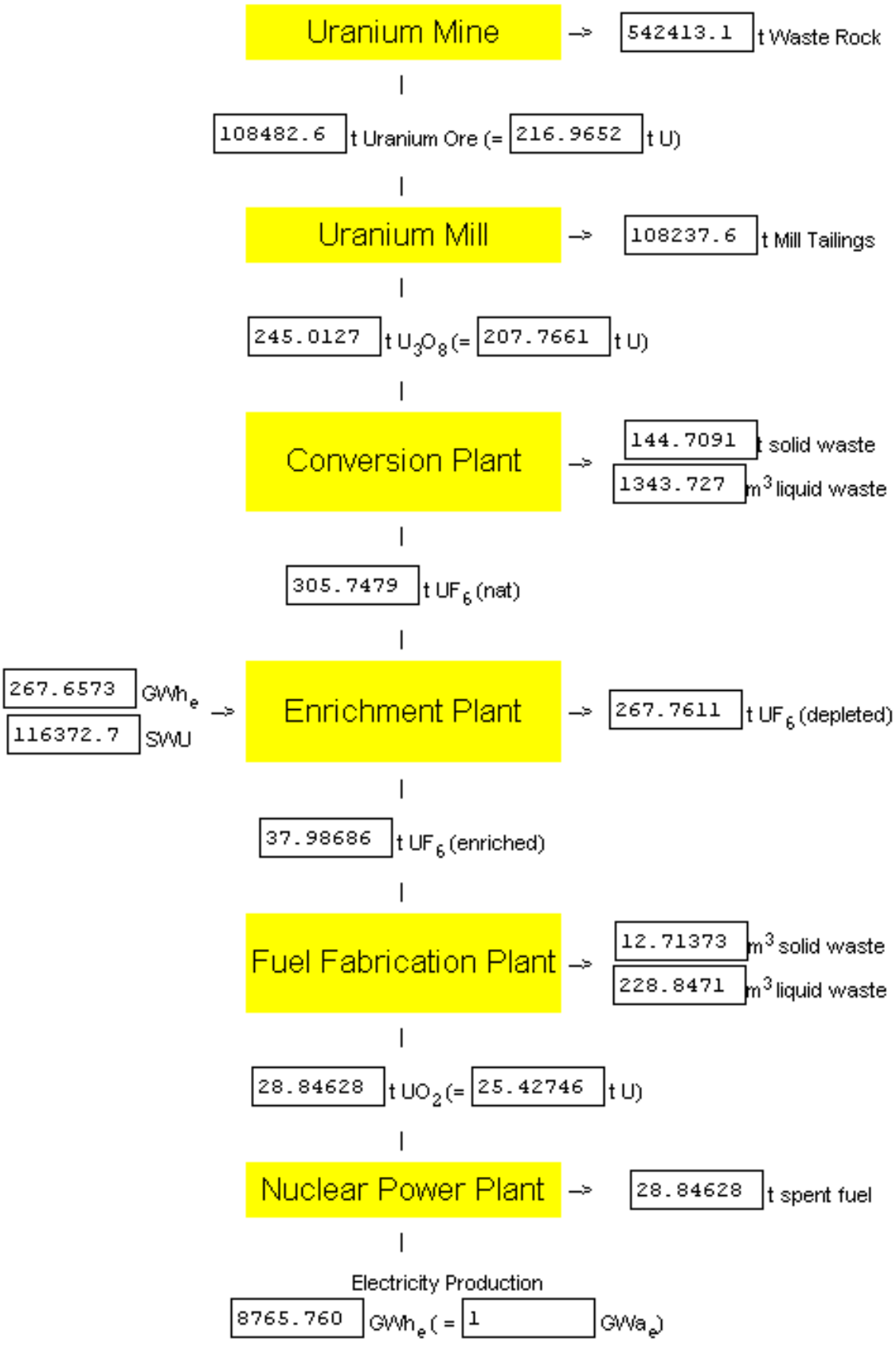
(this is a screenshot of the Nuclear Fuel Supply Calculator using the default parameters)

The next graph shows the lifetime of the known uranium resources recoverable at costs up to US$ 80/kg U for a middle demand scenario.



(this is a screenshot of the Nuclear Fuel Supply Calculator using the default parameters)

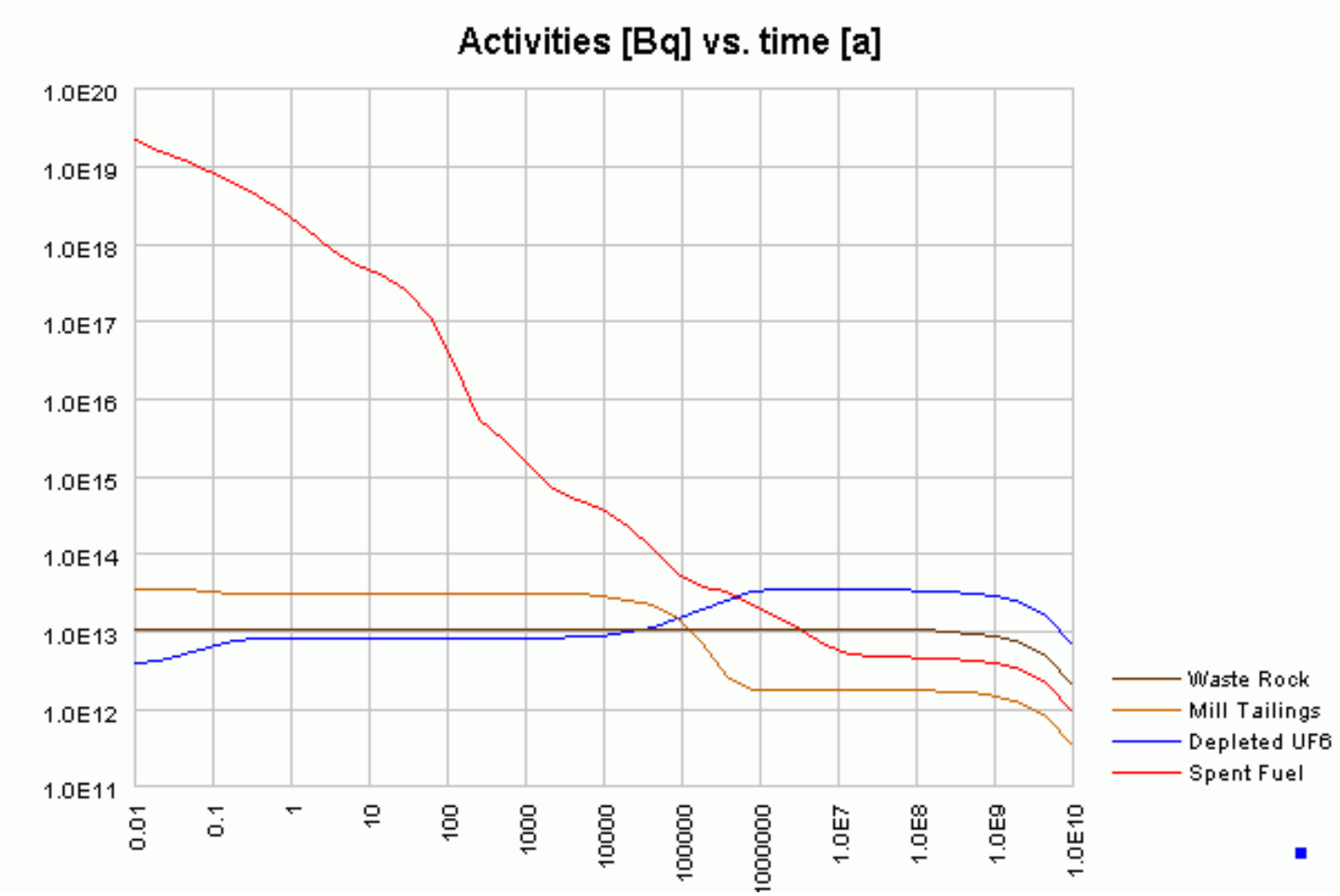
Nuclear Fuel Chain Material Balance for electricity production of 1 GWa(e)



(this is a screenshot of the Nuclear Fuel Material Balance Calculator using the default parameters)

Activities of nuclear fuel chain wastes arising from electricity production of 1 GWa(e)

In the beginning, the activity of the spent fuel is by far higher than from any other by-product of the fuel chain, but after approximately 500,000 years, the situation changes: while the activity of the spent fuel further decreases, that of the wastes from the front end of the fuel chain remains rather stable, or, even increases, as that of the depleted uranium left over from the enrichment process. The depleted uranium then becomes the major activity source for long periods of time. (note logarithmic scales!)

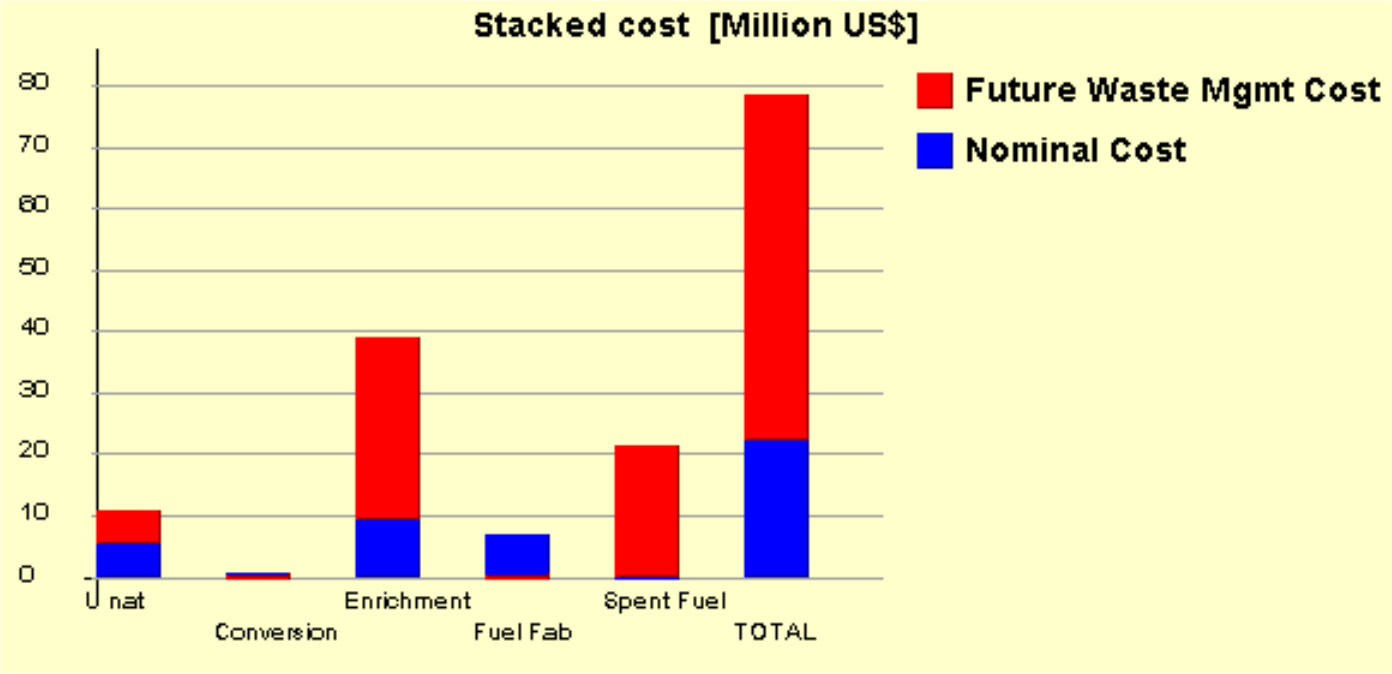


(this is a screenshot of the Nuclear Fuel Chain Waste Activity Calculator output chart using the default parameters)

Cost

Nuclear Fuel Cost Balance for electricity production of 1 GWa(e)

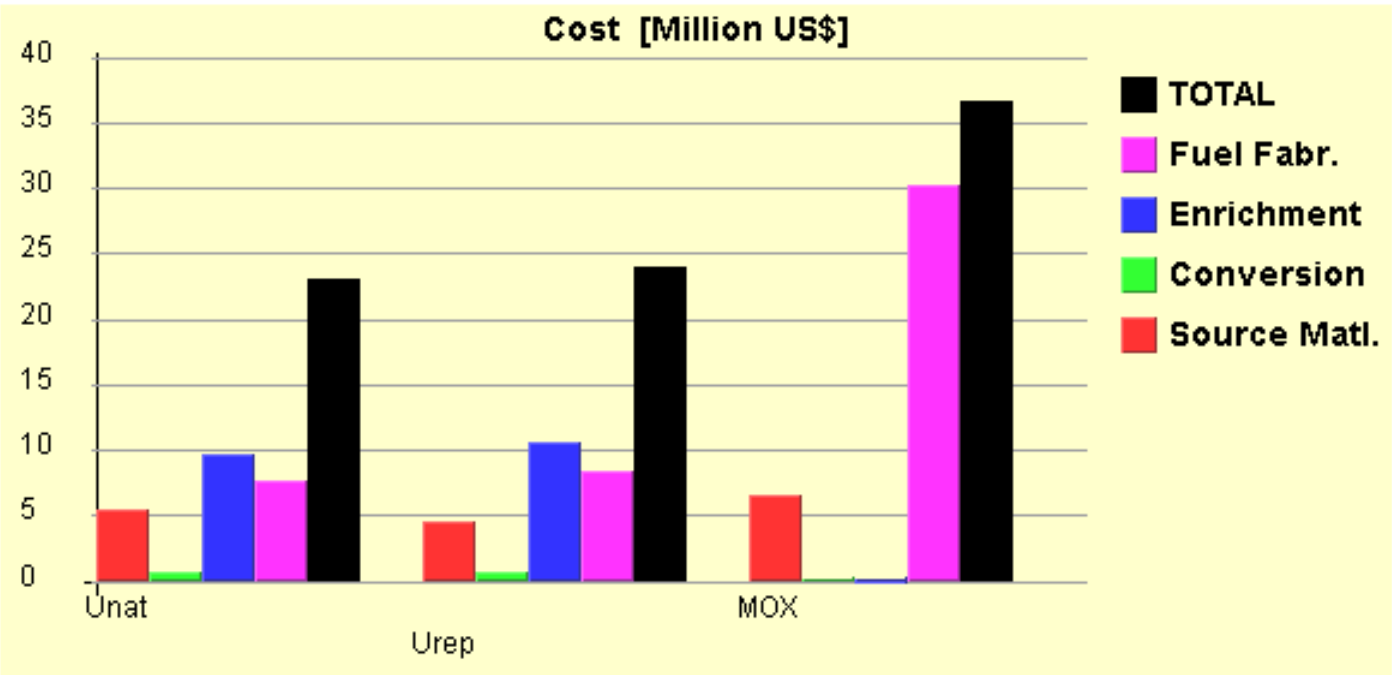
The current market prices of nuclear fuel do not include all of the costs incurring. While for uranium mill tailings, the long-term management cost not covered by the uranium price may be as high as the uranium cost itself, the situation for the depleted uranium waste arising during enrichment even may be worse. The total long-term waste management cost not covered by current nuclear fuel market prices thus may reach a multiple of the nominal costs.



(this is a screenshot of the Nuclear Fuel Cost Calculator output chart using the default parameters)

Recycled Nuclear Fuel Cost Balance for electricity production of 1 GWa(e)

Under current world market conditions, nuclear fuel from fresh uranium (Unat) is cheaper than from recycled uranium (Urep) or recycled plutonium (MOX).



(this is a screenshot of the Recycled Nuclear Fuel Cost Calculator output chart using the default parameters)

Health Risk for Residents

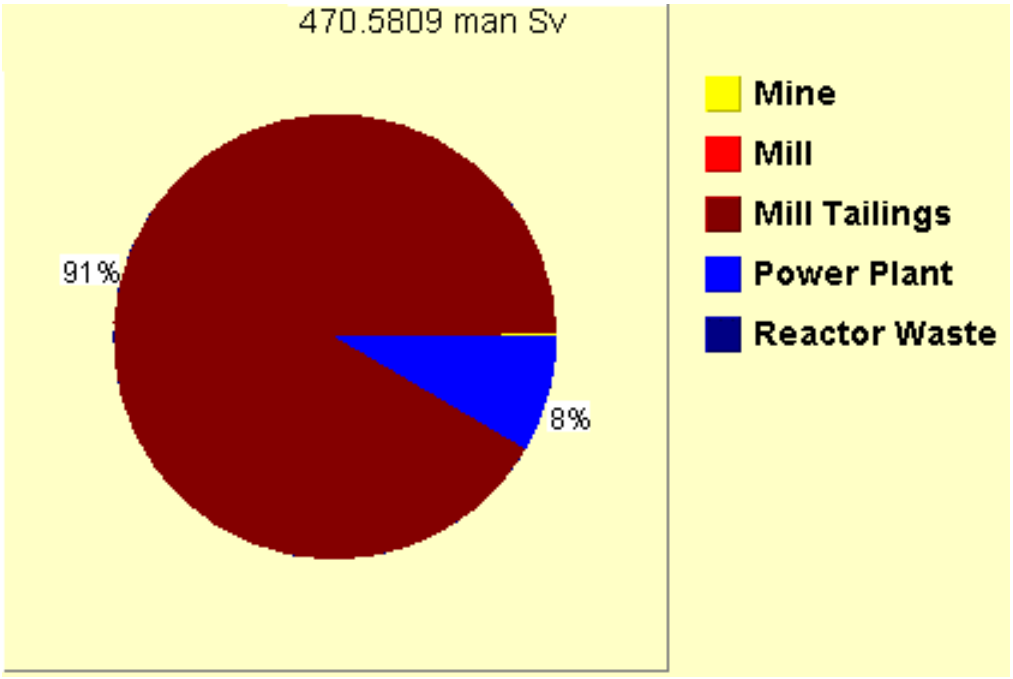
10,000-year collective population radiation dose from electricity production of 1 GWa (e)

In the long term, the continuing radon emissions from the uranium mill tailings and the long-lived nuclide C-14 released from the nuclear power plant cause the highest collective radiation doses by far for the general population.

These results were obtained with the Nuclear Fuel Population Health Risk Calculator. For details, check there.

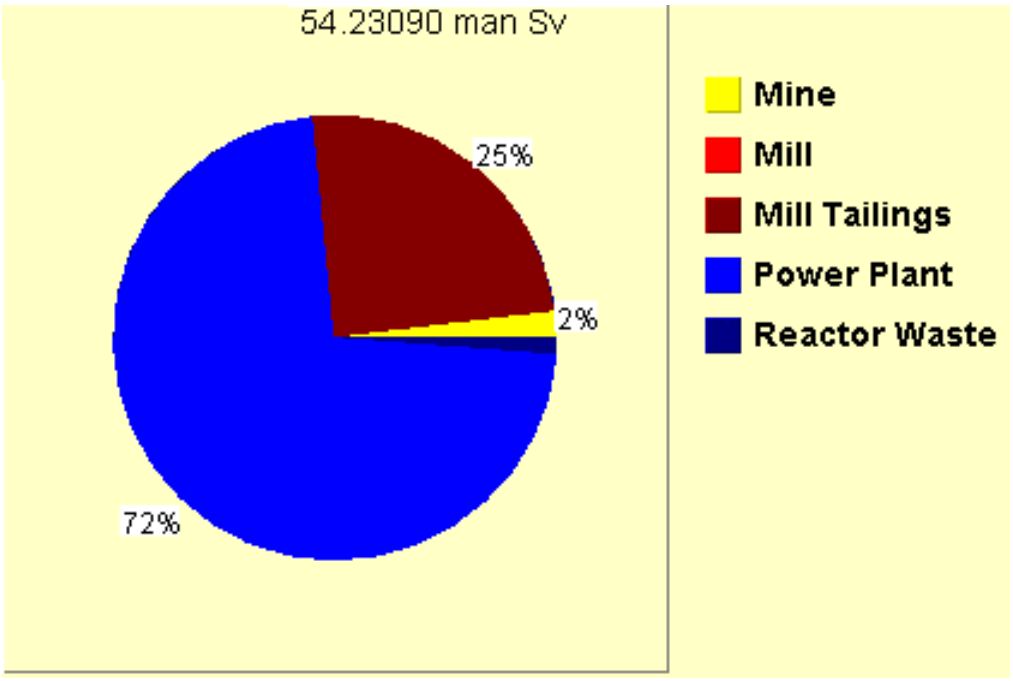
Global long-term collective dose from nuclear power use per Gigawatt-year electricity (GWa_e) produced, including the front and rear ends of the nuclear fuel cycle and the nuclear power plant. A linear no-threshold dose effect is assumed for these calculations.

a) Global collective dose: no tailings cover



91% of the global collective dose is caused from the abandoned tailings. With ICRP's dose-effect figure of 0.05 per Sv, each year of reactor operation is causative for 23.5 deaths from cancer in the long term.

b) Global collective dose: tailings cover limiting radon-222 emission rate after mill shutdown to 0.74 Bq/m^{2}s (= 20 pCi/m^{2}s)



The global collective dose is reduced by a factor of nine, supposed the tailings cover stays intact for thousands of years; 72% of the dose is now caused from the reactor operation, mainly from the release of C-14. Each year of reactor operation is causative for 2.7 deaths from cancer in the long term.

> For more calculators, see WISE Uranium Project Calculators

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